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5.7 PALEONTOLOGICAL RESOURCES

This section summarizes the potential environmental impacts on paleontological resources that may result from construction of the Salton Sea Unit 6 (SSU6) project. Section 5.7.1 describes the existing environment that could be affected by the proposed SSU6 project. Section 5.7.2 describes the potential impacts on paleontological resources resulting from construction and operation of the proposed project. The cumulative impacts to paleontological resources are discussed in Section 5.7.3. Proposed mitigation measures to reduce potential adverse impacts to paleontological resources are discussed in Section 5.7.4. Section 5.7.5 lists the federal, state, and county laws, ordinances, regulations, and standards (LORS) and the professional standards that protect paleontological resources. The involved agencies and agency contacts are provided in Section 5.7.5, along with the status of permits required and permit schedule. Section 5.7.5 lists the references used in preparing this document. Tables are found at the end of this section.

Paleontological resources (fossils) are the remains or traces of prehistoric plants and animals. Fossils are important scientific and educational resources because of their use in (1) documenting the presence and evolutionary history of particular groups of now extinct organisms, (2) reconstructing the environments in which those organisms lived, (3) and in determining the relative ages of the strata in which they occur and of the geologic events that resulted in the deposition of the sediments that buried them.

This paleontological resources inventory and impact assessment was prepared by Dr. Lanny H. Fisk, Ph.D., RG, a California registered geologist and a senior paleontologist with PaleoResource Consultants (PRC). It meets all requirements of the California Energy Commission (CEC, 2000) and the standard measures for mitigating adverse construction-related environmental impacts on significant paleontological resources established by the Society of Vertebrate Paleontology (SVP, 1995, 1996).

5.7.1 Affected Environment

5.7.1.1 Introduction

The proposed SSU6 Project is located south of the Salton Sea. This region of the Imperial Valley is used mostly for agriculture and geothermal power production. This section discusses the affected paleontological resources for the SSU6 Project. The geographic and regional setting information is presented, followed by a discussion of paleontological resource inventory methods. The resource inventory results are presented and summarized.

As described in the following subsections, the entire region of the SSU6 power plant site and all associated facilities are on Pleistocene and Holocene-age alluvial deposits of the fossiliferous Lake Cahuilla Beds and Brawley Formation, both of which have a high potential for paleontological resources. Consequently, the discussion of paleontological resources is presented for the entire project as a whole and not by components (e.g., power plant site, transmission lines, pipelines, etc.) to reduce redundancy.

5.7.1.2 Geographic Location

The site proposed for construction of the SSU6 Project is near the center of the Salton Basin, which is divided by the Salton Sea into the Coachella Valley to the north and the Imperial Valley to the south. The Imperial Valley comprises roughly the southern two-thirds of a major north-northwest-oriented structural and topographic depression variously called the Colorado Desert (Stearns, 1879; Preston, 1893; Fenneman, 1931), Salton Trough (Jahns, 1954; Muffler and White, 1969; Crowell and Baca, 1979; Waters, 1983; McKibben, 1993), Salton Sea Trough (Muffler and Doe, 1968), Salton Sink (Mendenhall 1909a, 1909b; Threet, 1978), Salton Basin (Buwalda and Stanton, 1930; Wilke, 1980; Gobalet, 1992, 1994), Salton Sea Basin (Stanley, 1962), Cahuilla Basin (Blake, 1914**;** Free, 1914), Imperial Basin (Rigsby, 1984; Dibblee, 1984), or Imperial Depression (Longwell, 1954). The Salton Trough Physiographic Province (Jahns, 1954) is between the Peninsular Range Physiographic Province on the west and the Basin and Range Physiographic Province on the east. The general project area is bounded on the west and north by the Salton Sea and on the east by a gently inclined alluvial fan, which heads in the Chocolate Mountains. The SSU6 Project plant site is in the USGS Obsidian Butte 7.5-minute (1:24,000 scale) Quadrangle. The ROWs of proposed electrical transmission lines traverse the following USGS 7.5-minute (1:24,000 scale) topographic quadrangles: Iris, Kane Spring, Kane Spring NE, Niland, Obsidian Butte, Westmorland East, and Westmorland West.

5.7.1.3 Regional Geologic Setting

The geology near the proposed site of the SSU6 Geothermal Power Plant and electrical transmission lines has been mapped or described by numerous workers, including Mendenhall (1909b), Brown (1920, 1923), Dibblee (1954, 1984), Longwell (1954), Merriam and Bandy (1965), Jennings (1967), Van de Kamp (1973), Morton (1977), Crowell and Baca (1979), Waters (1983), Rigsby (1984), and McKibben (1993), among others. Surficial geologic mapping of the project site and vicinity has been provided at a scale of 1:750,000 by Jennings (1977); at a scale of 1:500,000 by Jenkins (1938); at a scale of 1:250,000 by Brown (1923), Dibblee (1954), Jennings (1967), and Loeltz et al. (1975); and at a scale of 1:125,000 by Morton (1977). No larger scale (such as 1:24,000-scale) geologic maps are currently available for this area. The information in geologic maps and other published and unpublished reports form the basis of the following discussion. The site-specific geology of the SSU6 site is discussed in Section 5.2.1 The aspects of geology pertinent to paleontological resources are the types, distribution, and age of sediments immediately underlying the project area and their probability of producing fossils during project construction.

The alluvial deposits accumulated in the Imperial Valley consist of a thick sequence of medium- to fine-grained sediment deposited by the Colorado River and local streams, which drain off the foothills of the surrounding mountain ranges (Crowell and Baca, 1979). These deposits generally grade basin-ward through gradually decreasing grain sizes from coarse pebble to cobble gravel in the foothills to clay-rich silt on the Salton Sea flood plain. The fine sands, silts, and clays that compose the lacustrine deposits near the center of the Imperial Valley have in the past produced abundant fossils, primarily invertebrates, fishes, birds, and large and small land mammals. These paleontological resources are discussed below.

Geological materials composing this thick sediment accumulation have been subdivided into stratigraphic units based on differences in lithology and age. Immediately near the project, sediments composing the Colorado River alluvial fan and delta have been divided into four stratigraphic units, from oldest to youngest: weakly cemented siltstone, sandstone, and conglomerate of the Pliocene marine Imperial Formation; finer grained sediments of the Early Pleistocene mixed marine and nonmarine Borrego Formation; a slightly younger (Middle Pleistocene to Early Holocene) and less consolidated, but otherwise similar sedimentary sequence known as the Brawley Formation; and Late Pleistocene to Holocene sediments informally named the "Lake Cahuilla Beds." Because they were derived from a common source and deposited in similar environments, the Borrego Formation, Brawley Formation, and Lake Cahuilla Beds are not easily distinguished from one another. The principal differences between the older and younger lacustrine sediments are stratigraphic position, degree of consolidation, topographic expression, attitude (tilted versus flat-lying), and fossil content. Neither the Imperial Formation nor Borrego Formation is present at or near the surface of any proposed SSU6 Project feature. Because they will not be impacted by project construction, they will not be discussed further in this report.

The Quaternary alluvium on the Imperial Valley plain assigned to the Lake Cahuilla Beds is lithologically indistinct from the underlying Brawley Formation, but can be distinguished from it by stratigraphic position, degree of consolidation (and therefore topographic expression), amount of deformation, and age. The Brawley Formation is believed to be Pleistocene to possibly Early Holocene in age, while the age of the Lake Cahuilla Beds is probably entirely Holocene (although both Stanley [1962] and Thomas [1963] have presented evidence for a Pleistocene age for the oldest Lake Cahuilla Beds). Strata comprising the Brawley Formation have been deformed by tectonic activity related to movement on the San Andreas and related faults and can often be recognized from the overlying Lake Cahuilla Beds by their non-flat-lying attitude. Because of its greater consolidation and cementation, the older stratigraphic unit also often has a distinct topographic expression. As streams cut through these older deposits, remnants were preserved as topographic highs.

5.7.1.4 Resource Inventory Methods

To develop a baseline paleontological resource inventory of the proposed SSU6 Project area, and to assess the potential paleontological productivity of each stratigraphic unit present, the published as well as available unpublished geological and paleontological literature was reviewed; and stratigraphic and paleontologic inventories were compiled, synthesized, and evaluated. These methods are consistent with CEC (2000) and SVP (1995) guidelines for assessing the importance of paleontological resources in areas of potential environmental effect. No subsurface exploration was conducted for this assessment.

Geologic maps and reports covering the surface and subsurface geology of the project site and vicinity were reviewed to determine the exposed and subsurface rock units, to assess the potential paleontological productivity of each rock unit, and to delineate their respective areal distribution in the project area. Additionally, available soil surveys and aerial photographs of the area were examined to aid in determining the areal distribution of distinctive sediment and soil types.

The number and locations of previously recorded fossil sites from rock units exposed in and near the project site and the types of fossil remains each rock unit has produced were evaluated based on published and unpublished geological and paleontological literature (including previous environmental impact assessment documents and paleontological resource impact mitigation program final reports). The literature review was supplemented by archival searches conducted at the San Bernardino County Museum (SBCM) and University of California Museum of Paleontology (UCMP) in Berkeley, for additional information regarding the occurrence of fossil sites and remains in and near the project site.

Field surveys, which included a visual inspection of exposures of potentially fossiliferous strata in the project area, were conducted to document the presence of sediments suitable for containing fossil remains and the presence of any previously unrecorded fossil sites. Stratigraphy was observed in the banks of numerous irrigation ditches, dry washes, and stream banks during field surveys. The field surveys for this assessment were conducted on 13 and 14 March 2002 by Mr. Patrick W. Riseley, MSc, RG, field geologist and paleontologist with PRC.

5.7.1.5 Paleontological Resource Assessment Criteria

CEQA and SVP (1995) methodology generally considers all fossil specimens significant, unless demonstrated otherwise, and, therefore, protected by environmental statutes. This position is held because fossils are uncommon and only rarely will a fossil locality yield a statistically significant number of specimens representing the same species. In fact, vertebrate fossils are so uncommon that, in most cases, each fossil specimen found provides additional important information about the characteristics or distribution of the species it represents.

A stratigraphic unit (such as a formation, member, or bed) known to contain significant fossils is considered "*sensitive*" to adverse impacts if there is a high probability that earth-moving or ground-disturbing activities in that rock unit will either disturb or destroy fossil remains. This definition of sensitivity differs fundamentally from that for archeological resources:

> *"It is very important to make the distinction between archaeologic resource sites and paleontologic resource sites when defining sensitivity. Archaeologic site boundaries define the limit of the extent of the resource. Paleontologic sites, however, serve as indicators that the sedimentary unit or formation in which they are found is fossiliferous. The boundaries of an entire fossiliferous formation, therefore, define the limits of paleontologic sensitivity in a given region" (SVP 1991).*

This distinction between archeological and paleontological sites is important. Most archeological sites have a surface expression that allows for their geographic location. Fossils, on the other hand, are an integral component of the rock unit below the ground surface, and, therefore, are not observable unless exposed by erosion or human activity. Thus, a paleontologist cannot know either the quality or quantity of fossils present before the rock unit is exposed because of natural erosion processes or earth-moving activities. The paleontologist can only make conclusions on sensitivity to impact based on what fossils have been found in the rock unit in the past, along with a judgment on whether the depositional environment of the sediments that compose the rock unit was likely to result in the burial and preservation of fossils.

Fossils are seldom uniformly distributed within a rock unit. Most of a rock unit may lack fossils, but at other locations within the same rock unit concentrations of fossils may exist. Even within a fossiliferous portion of the rock unit, fossils may occur in local concentrations. For example, Shipman (1977, 1981) excavated a fossiliferous site using a three-dimensional grid and removed blocks of matrix of a consistent size. The site chosen was known prior to excavation to be richly fossiliferous, yet only 17 percent of the blocks actually contained fossils. These studies demonstrate the physical basis for the difficulty in predicting the location and quantity of fossils in advance of project-related ground disturbance.

Because it is impossible to determine where fossils are without actually disturbing a rock unit, monitoring of excavation by an experienced paleontologist during construction increases the probability that fossils will be discovered and preserved. Preconstruction mitigation measures such as surface prospecting and collecting will not prevent adverse impacts on fossils because many sites will be unknown in advance because of an absence of fossils at the surface.

The non-uniform distribution of fossils within a rock unit is essentially universal and many paleontological resource assessment and mitigation reports conducted in support of environmental impact documents and mitigation plan summary reports document similar findings (see for instance Lander, 1989, 1993; Reynolds, 1987, 1990; Spencer, 1990; Fisk et al., 1994; and references cited therein). In fact, most fossil sites recorded in reports of impact mitigation (where construction monitoring has been implemented) had no previous surface expression. Because the presence or location of fossils within a rock unit cannot be known without exposure resulting from erosion or excavation, under SVP (1991, 1995) standard guidelines, an entire rock unit is assigned the same level of sensitivity based on previously recorded fossil occurrences.

Using SVP (1991, 1995) criteria, the paleontological importance or sensitivity (high, low, or undetermined) of each rock unit exposed in a project site or surrounding area is the measure most amenable to assessing the significance of paleontological resources because the areal distribution of each rock unit can be delineated on a topographic or geologic map. The paleontological importance of a stratigraphic unit reflects: (1) its potential paleontological productivity (and thus sensitivity), and (2) the scientific significance of the fossils it has produced. This method of paleontological resources assessment is the most appropriate because discrete levels of paleontological importance can be delineated on a topographic or geologic map.

The potential paleontological productivity of a stratigraphic unit exposed in a project area is based on the abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near a project site. The underlying assumption of this assessment method is that exposures of a stratigraphic unit in a project site are most likely to yield fossil remains both in quantity and density similar to those previously recorded from that stratigraphic unit in and near the project site.

An individual fossil specimen is considered scientifically important if it is:

- Identifiable,
- Complete,
- Well preserved,
- Age diagnostic,
- Useful in paleoenvironmental reconstruction,

- A type or topotypic specimen,
- A member of a rare species,
- A species that is part of a diverse assemblage, and/or
- A skeletal element different from, or a specimen more complete than, those now available for that species.

Identifiable land mammal fossils are considered scientifically important because of their potential use in providing accurate age determinations and paleoenvironmental reconstructions for the sediments in which they occur. Moreover, vertebrate remains are comparatively rare in the fossil record. Although fossil plants are usually considered of lesser importance because they are less helpful in age determination, they are actually more sensitive indicators of their environment and, thus, as sedentary organisms, more valuable than mobile animals for paleoenvironmental reconstructions. For marine sediments, invertebrate and marine algal fossils, including microfossils, are scientifically important for the same reasons that land mammal and/or land plant fossils are valuable in terrestrial deposits. The value or importance of different fossil groups varies depending on the age and depositional environment of the stratigraphic unit that contains the fossils.

The following tasks were completed to establish the paleontological importance and sensitivity of each stratigraphic unit exposed in the project area:

- The potential paleontological productivity of each rock unit was assessed based on the density of fossil remains and/or previously recorded and newly documented fossil sites it contains in and/or near the project site.
- The scientific importance of fossil remains recorded from a stratigraphic unit exposed in the project site was assessed.
- The paleontological importance of a rock unit was assessed, based on its documented and/or potential fossil content in the area surrounding the project site.

5.7.1.5.1 Categories of Sensitivity

In its standard guidelines for assessment and mitigation of adverse impacts to paleontological resources, the SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined.

High Sensitivity

Stratigraphic units in which fossils have been previously found have a high potential to produce additional fossils and are therefore considered highly sensitive.

Low Sensitivity

Stratigraphic units that are not sedimentary in origin or that have not been known to produce fossils in the past are considered to have low sensitivity. Monitoring is usually not recommended nor needed during project construction through a stratigraphic unit with low sensitivity.

Undetermined Sensitivity

Stratigraphic units that have not had any previous paleontological resource surveys or any fossil finds are considered to have undetermined sensitivity. After reconnaissance surveys, observation of artificial exposures (such as road cuts) and natural exposures (such as stream banks), and possible subsurface testing (such as augering or trenching), an experienced, professional paleontologist can often determine whether the stratigraphic unit should be categorized as having high or low sensitivity.

In keeping with the significance criteria of the SVP (1995), all vertebrate fossils are categorized as having significant scientific value and all stratigraphic units in which vertebrate fossils have previously been found have high sensitivity.

5.7.1.6 Resource Inventory Results

5.7.1.6.1 Stratigraphic Inventory

Regional geologic mapping of the proposed SSU6 Project vicinity has been provided by Jennings (1977; 1:750,000 scale), Jenkins (1938; 1:500,000 scale), Brown (1923, 1:250,000 scale), Dibblee (1954, 1:250,000 scale), Jennings (1967; 1:250,000 scale), Loeltz et al. (1975, 1:250,000 scale), and Morton (1977, 1:125,000). No larger scale mapping of the project site is available. Unfortunately, in their geologic maps of the Late Cenozoic deposits of the project area, geologists have not always used formally named stratigraphic units; nor have they consistently used the same map units.

Jennings (1967, 1:250,000 scale) mapped the area near the proposed SSU6 plant site and the ROWs of the proposed electrical transmission lines as "Quaternary lake deposits," which he defined as "Lake Coahuila (Cahuilla) deposits." The west end of the L-Line Interconnection was mapped by Jennings (1967) as "Pleistocene nonmarine sedimentary deposits," which he defined as Brawley Formation. Jennings (1967) explained that "where intimately associated with Lake Coahuila [sic] Deposits" the Brawley Formation lacustrine sediments were also mapped as "Quaternary lake deposits." Loeltz et al. (1975, 1:250,000 scale) showed that the project site and surrounding Salton Sea flood plain are underlain by Pleistocene and Holocene "Lake deposits", which they stated included "the Brawley Formation exposed along the perimeter of the trough and deposits of Lake Cahuilla in the middle of the trough." Morton (1977, 1:125,000) mapped the SSU6 plant site and Salton Sea flood plain as Quaternary "Lake beds", which he recognized as "sediments of ancient Lake Cahuilla." The west end of the L-Line Interconnection was mapped by Morton (1977) as Brawley Formation.

These previous interpretations of the geology at the project site are supported by soil surveys (Zimmerman, 1981). Soil maps of the project site indicate significant changes in soil types corresponding to changes in the underlying sediments. For instance, soils over most of the project area have been mapped as "*Imperial-Holtville-Glenbar*" or "*Fluvaquents*" and described as poorly to moderately well drained clay and silty clay. Zimmerman (1981) stated that these soils developed in the lacustrine basin formerly occupied by prehistoric Lake Cahuilla. Soils on the margin of the Salton Sea flood plain are mapped as "*Meloland-Vint-Indio*" and described as well drained fine to very fine sand and silt (Zimmerman 1981). These soil descriptions support the interpretation that soils referred to the *Meloland-Vint-Indio* formed on older sediments of the Brawley Formation, while soils referred to the *Imperial-Holtville-Glenbar* and *Fluvaquents* formed on younger lacustrine sediments of the Lake Cahuilla Beds. Thus, the geologic maps of

Jennings (1967), Loeltz et al. (1975), and Morton (1977) and the soil maps of Zimmerman (1981) are in excellent agreement that most of the project site is underlain by sediments of Lake Cahuilla Beds, except for the west end of the L-Line Interconnection, where both the L-Line Interconnection and Alternate L-Line Interconnection cross sediments of the Brawley Formation.

An additional line of evidence in support of this interpretation comes from geomorphology. Aerial photos clearly show that the surface of most of the project area has very low relief, except near the west end of the L-Line Interconnection, where the topography changes to a deeply eroded, gently inclined slope. This change in topography and erosion style marks the contact between the Lake Cahuilla Beds and Brawley Formation.

5.7.1.6.2 Site Geology

Geologic mapping by Brown (1923, 1:250,000 scale), Dibblee (1954, 1:250,000 scale), Jennings (1967, 1:250,000 scale), Loeltz et al. (1975, 1:250,000 scale), and Morton (1977, 1:125,000 scale) indicate that the SSU6 plant site is underlain by lacustrine deposits of the Lake Cahuilla Beds overlying deposits referable to the Brawley Formation. The entire IID Midway Interconnection route is underlain by lacustrine Lake Cahuilla sediments as well. The younger Cahuilla Lake Beds form a relatively thin sedimentary deposit over the older Brawley Formation. Thus, although the Cahuilla Lake Beds are mapped as being present at the surface over most of the project area, the older Brawley Formation may still be encountered in deep excavations, such as foundations for electrical transmission line towers. Sediments of both these formations have yielded fossilized remains of continental vertebrates, invertebrates, and plants at numerous previously recorded fossil sites in the Imperial Valley (see discussion below).

Lake Cahuilla Beds

The Lake Cahuilla Beds were first named by Blake (1854, 1907). They consist of interbedded reddish-brown to gray, unconsolidated silty clays, silts, and fine sands deposited in prehistoric Lake Cahuilla. Whistler et al. (1995) placed the age of the Lake Cahuilla Beds between 6,000 and 300 years BP, Middle to Late Holocene. However, both Stanley (1962) and Thomas (1963) independently suggested that the oldest sediments deposited in Lake Cahuilla may be Late Pleistocene. Fossils from a Lake Cahuilla shoreline yielded a Late Pleistocene radiocarbon date of 37,100 $^{+}$/- 2,000 years before present (Hubbs et al., 1963).

Brawley Formation

The Brawley Formation was named and described by Dibblee (1954). The Brawley Formation is composed of interbedded, reddish-brown to gray, poorly sorted, clayey silts and fine sands. Locally these sediments are weakly cemented with calcareous and/or hematite cements, but in other nearby locations they are uncemented. These beds are primarily lacustrine (lake) or fluvial (stream) deposits. The Brawley Formation is Pleistocene in age based on stratigraphic superposition and age-diagnostic fossils. However, several geologists have suggested that the youngest Brawley Formation sediments may be Early Holocene in age.

5.7.1.6.3 Paleontological Resource Inventory

An inventory of the paleontologic resources of each stratigraphic unit exposed at the proposed project site is presented below and the paleontological importance of these resources is assessed. The literature review and SBCM and UCMP archival searches conducted for this inventory documented no previously recorded fossil sites within the limited footprint of the SSU6 Project facilities. However, numerous fossil sites were documented as occurring in sediments of the Lake Cahuilla Beds and Brawley Formation. Additionally, fossil remains were found at several previously unrecorded fossil sites during the field survey of the proposed project site and vicinity conducted for this assessment.

Numerous vertebrate fossil localities have been reported from sediments referable to the Lake Cahuilla Beds and Brawley Formation in the general vicinity of the proposed SSU6 Project. Surveys of Quaternary land mammal fossils of California have been made by Hay (1927), Lundelius et al. (1983), and Jefferson (1991b), and surveys of Quaternary birds, reptiles, and amphibians have been made by Miller and DeMay (1953) and Jefferson (1991a).

Lake Cahuilla Beds

The Lake Cahuilla Beds have yielded fossil remains at numerous sites in the Imperial Valley. Blake (1907) stated that the sediments of ancient Lake Cahuilla contained "*myriads of fossil fresh-water shells*." Stearns (1879) used language such as "*vast multitude*" and "*untold millions*" in reference to Lake Cahuilla fossil invertebrates. Jennings (1967) stated that the Lake Cahuilla deposits "*contain abundant nonmarine fossils*." In addition to invertebrates (primarily snails, clams, and ostracods), these fossil remains include wood (Stanley 1962; Van de Kamp, 1973; Whistler et al., 1995), seeds (Waters, 1983), pollen (Whistler et al., 1995), diatoms (Whistler et al., 1995); foraminifera (Van de Kamp, 1979); sponges (Whistler et al., 1995), fish (Hubbs and Miller, 1948; Gobalet, 1992, 1994; Wilke, 1980; Schoenherr, 1993; Whistler et al., 1995), birds (Whistler et al., 1995), and the bones and teeth of a diversity of land mammals (Whistler et al., 1995). Whistler et al. (1995) reported teeth and bones of rodents, rabbits, reptiles (tortoises, lizards, and snakes), horses, and desert bighorn sheep from sediments of the Lake Cahuilla Beds. During a field survey of prospective fossiliferous sediments near the project site on 13 and 14 March 2002, Mr. Riseley found fossil mollusks in Lake Cahuilla Beds in the banks of irrigation ditches and the New River at three localities (see Appendix I). All these localities are less than 1 mile from the proposed electrical transmission line In summary, sediments referable to the Lake Cahuilla Beds have yielded scientifically significant fossils in the past and several previously unrecorded fossil localities were found less than 1 mile from the proposed project site. Although no fossils are known to directly underlie the proposed SSU6 Project plant site or ROW of the electrical transmission lines, the presence of fossil sites in Lake Cahuilla Beds within 1 mile of the proposed project site suggests that there is a high potential for fossil remains to be uncovered by excavations at the proposed SSU6 site. Because this unit in the past has produced significant fossils, under SVP (1995) criteria the Lake Cahuilla Beds are judged to have high sensitivity. Additional fossil remains recovered from the Lake Cahuilla Beds during project construction may be scientifically important and significant.

Brawley Formation

Fossils have also been previously reported from Brawley Formation sediments at numerous scattered locations. Fossils previously reported from the Brawley Formation include ostracods, foraminifera, snails, clams, fish, horses, other unidentified large mammals, and land plant remains (including wood). Herzig and Mehegan (1987) reported gastropods and ostracods in well cuttings from sediments at shallow depths that are probably Brawley Formation. These fossil remains from the Brawley Formation are scientifically highly significant because the taxa they represent previously had been unreported or only very rarely reported from the fossil record of California. Moreover, continental vertebrate remains are comparatively rare in the fossil record. Additionally, paleontological data derived from a study of the fossil remains, in conjunction with geologic (particularly geochronologic, sedimentologic, and paleomagnetic) evidence, have been significant in documenting the origin and age of the Brawley Formation and in reconstructing the Pleistocene geologic history of the Imperial Valley and Salton Sea area.

Because fossil vertebrates have been previously reported from this formation, and because depositional conditions appear to be favorable for the preservation of fossils, the Brawley Formation is judged to also have high sensitivity. There is a high potential for paleontological resources to be negatively impacted during ground disturbance in sediments of the Brawley Formation.

5.7.1.6.4 Summary

Although no fossils are known to directly underlie the proposed SSU6 Project plant site or the ROW of the proposed linear facilities, the presence of fossil sites in alluvial deposits of the Cahuilla Lake Beds and Brawley Formation elsewhere suggests that there is a high potential for additional similar fossil remains to be uncovered by excavations in these formations during SSU6 Project construction. Under SVP (1995) criteria, both these formations have a high sensitivity for producing additional paleontological resources. Fossil remains recovered from either formation during SSU6 Project construction may be scientifically important and significant.

5.7.2 Environmental Consequences

Potential impacts on paleontological resources resulting from construction of the proposed project can be divided into construction-related impacts and operation-related impacts. Construction-related impacts to paleontological resources primarily involve terrain modification (excavations and drainage diversion measures). Paleontologic resources, including an undetermined number of fossil remains and unrecorded fossil sites; associated specimen data and corresponding geologic and geographic site data; and the fossil-bearing strata, could be adversely affected by (i. e., would be sensitive to) ground disturbance and earth moving associated with construction of the project. Direct impacts would result from vegetation clearing, grading of roads and the generating facility site, trenching for pipelines, augering for foundations for electrical towers or poles, and any other earth-moving activity that disturbs or buries previously undisturbed fossiliferous sediments, making those sediments and their paleontologic resources unavailable for future scientific investigation. A paleontological resource can be significant if:

- It provides important information on the evolutionary trends among organisms, relating living organisms to extinct organisms.
- It provides important information regarding development of biological communities or interaction between botanical and zoological biota.
- It demonstrates unusual circumstances in biotic history.
- It is in short supply and in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and is not found in other geographic localities.

The potential environmental effects from construction and operation of the project on paleontological resources are presented in the following subsections.

Significant resources are defined in this report to include the interpretation outlined by SVP (1995), wherein all vertebrate fossils are categorized as having significant scientific value. Identifiable fossil remains recovered during project construction could represent new taxa or new fossil records for the area, for the State of California, or for a formation. They could also represent geographic or temporal range extensions. Moreover, discovered fossil remains could make it possible to more accurately determine the age, paleoclimate, and depositional environment of the sediments from which they are recovered. Finally, fossil remains recovered during project construction could provide a more comprehensive documentation of the diversity of animal and plant life that once existed in Imperial County and could result in a more accurate reconstruction of the geologic history of the Imperial Valley and Salton Sea area. The potential environmental effects from construction and operation of the project on paleontological resources are presented in the following subsections.

5.7.2.1 Potential Impacts from Project Construction

The proposed project site is on Pleistocene and Holocene-age alluvial deposits of the fossiliferous Lake Cahuilla Beds and Brawley Formation. The planned site clearing, grading, and deeper excavation at the site are expected to result in significant adverse impacts to paleontological resources. Additionally, the construction of supporting facilities, such as temporary construction offices, laydown area, and parking areas, have potential to cause adverse impacts on significant paleontological resources, as they also will involve significant new ground disturbance. Similarly, deeper excavations at the plant site for foundations for turbines, trenching for the water supply line, and electrical transmission line would disturb Pleistocene and Holocene alluvium that contains significant fossils elsewhere. Thus, any project-related ground disturbance could have adverse impacts on significant paleontological resources.

5.7.2.2 Potential Impacts from Project Operation

No impacts on paleontological resources are expected to occur from the continuing operation of the project or any of its related facilities.

5.7.3 Cumulative Impacts

If the project were to encounter paleontological finds during construction, the potential cumulative effect would be less than significant, as long as mitigation measures were implemented to recover the resources. The mitigation measures proposed in Section 5.7.4 would effectively recover the value to science of significant fossils recovered.

5.7.4 Mitigation Measures

This section describes proposed mitigation measures that will be implemented to reduce potential adverse impacts to significant paleontological resources resulting from project construction. Mitigation measures are necessary because of potential adverse impacts of project construction on significant paleontological resources within the Lake Cahuilla Beds and Brawley Formation. The proposed paleontologic resource impact mitigation program would reduce, to a less than significant level, the direct, indirect, and cumulative adverse environmental impacts on paleontologic resources that could result from project construction. The mitigation measures proposed below for the project are consistent with CEC environmental guidelines (CEC, 2000) and with SVP standard guidelines for mitigating adverse construction-related impacts on paleontologic resources (SVP 1995, 1996).

- **Paleo-1:** Prior to construction, a qualified paleontologist will be retained to both design a monitoring and mitigation program and implement the program during project-related earth-moving activities at the generating facility site, including deep boring for electrical transmission towers, construction of the water supply line, and for all other project-related activities involving ground disturbance. The paleontological resource monitoring and mitigation program will include protocols for construction monitoring; emergency discovery procedures; sampling and data recovery, if needed; museum storage of any specimen and data recovered; preconstruction coordination; and reporting. Prior to the start of construction, the paleontologist will conduct a field survey of exposures of sensitive stratigraphic units within the construction site that will be disturbed. Earth-moving construction activities will be monitored where this activity will disturb previously undisturbed sediment. Monitoring will not be conducted in areas where the ground has been previously disturbed or in areas where exposed sediment will be buried but not otherwise disturbed.
- **Paleo-2:** Prior to the start of construction, construction personnel involved with earth-moving activities will be educated with regard to the appearance of fossils and proper notification procedures. This crew education program will be prepared and presented by a qualified paleontologist.

Implementation of these mitigation measures will reduce the potentially significant adverse environmental impact of ground disturbance and earth-moving on paleontological resources within the proposed project area to a less than significant level by allowing for the recovery of fossil remains, associated specimen data and corresponding geologic and geographic site data that otherwise might be lost to earth-moving and to unauthorized fossil collecting.

With a well designed and implemented paleontological resource monitoring and mitigation plan, project construction could actually result in beneficial effects on paleontological resources through the recovery of fossil remains that would not have been exposed without project construction and, therefore, would not have been available for study. The recovery of fossil remains as part of project construction could help answer important questions regarding the geographic distribution, stratigraphic position, and age of fossiliferous sediments in the project area.

5.7.5 Applicable Laws, Ordinances, Regulations, and Standards

Paleontological resources are classified as non-renewable scientific resources and are protected by several federal and state statutes (California Office of Historic Preservation, 1983; Marshall, 1976; Fisk and Spencer, 1994), most notably by the 1906 Federal Antiquities Act and other subsequent federal legislation and policies and by the State of California's environmental regulations (California Environmental Quality Act [CEQA], Section 15064.5). Design, construction, and operation of the proposed SSU6 Project, including ancillary facilities, will be conducted in accordance with LORS applicable to paleontological resources. Federal and state LORS applicable to paleontological resources are summarized in Table 5.7-1 and discussed briefly below.

5.7.5.1 Federal Laws, Ordinances, Regulations, and Standards

Federal protection for significant paleontological resources would apply to the project if any construction or other related project impacts occurred on federally owned or managed lands. Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (PL 59-209; 16 United States Code 431 *et seq.*; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal land. The BLM would require project consistency with this federal legislation during the ROW grant process through BLM lands.

5.7.5.2 State Laws, Ordinances, Regulations, and Standards

The CEC environmental review process required under the Warren-Alquist Act is considered functionally equivalent to that of CEQA; Public Resources Code Sections 15000 et seq. with respect to paleontological resources. Guidelines for the Implementation of CEQA, as amended March 29, 1999 (Title 14, Chapter 3, California Code of Regulations: 15000 *et seq*.) define procedures, types of activities, persons, and public agencies required to comply with CEQA, and include as one of the questions to be answered in the Environmental Checklist (Section 15023, Appendix G, Section XIV, Part a) the following: "*Will the proposed project disturb paleontological resources?*"

Other state requirements for paleontological resources management are in Public Resources Code Chapter 1.7, Section 5097.5, Archaeological, Paleontological, and Historical Sites. This statute specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources and defines any unauthorized disturbance or removal of a fossil site or remains on public land as a misdemeanor. This would apply to the SSU6 project only if any construction or other related project impacts occurred on state owned or managed lands or if the state or a state agency were to obtain ownership of project lands during the term of the project license.

5.7.5.3 County Laws, Ordinances, Regulations, and Standards

Imperial County does not have mitigation requirements that specifically address potential adverse impacts to paleontological resources. However, the Land Use Element of the Imperial County General Plan, which serves as the primary policy statement by the County Board of Supervisors for implementing development policies and land uses, contains in its Goals and Objectives statements that provide direction for private development and guidelines for land use decision making. These Goals and Objectives repeatedly mention preserving natural resources and the natural environment and avoiding adverse environmental impacts. Objective 8.8 specifically states that the siting of future facilities for the transmission of electricity should be compatible with the environment. Goal 9 deals with the protection of environmental resources and states that the County will identify and preserve significant natural, cultural, and community character resources. Objective 9.1 requires the preservation of important natural resources, including prehistoric sites. The SSU6 Project would achieve these objectives with the implementation of the mitigation measures specified in Section 5.7.4.

5.7.5.4 Involved Agencies and Agency Contacts

There are no state or local agencies having specific jurisdiction over paleontological resources. Federal agency contacts are listed in Table 5.7-2.

5.7.5.5 Permits Required and Permit Schedule

No state or county agency requires a paleontological collecting permit to allow for the recovery of fossil remains discovered because of construction-related earth moving on state or private land in a project site. A federal Antiquities Act Permit would be required from the BLM for the collection of fossils from BLM-owned or managed lands. This permit would be obtained at least 30 days prior to construction on BLM-managed lands.

5.7.6 References

Blake, W. P., 1854, Ancient lake in the Colorado Desert: American Journal of Science, vol. 17, p. 435-438.

Blake, W. P., 1907, Lake Cahuilla -- the ancient lake of the Colorado Desert: National Geographic Magazine, vol. 18, p. 830.

Blake, W. P., 1914, The Cahuilla Basin and desert of the Colorado: p. 1-12 in MacDougal, D. T. (editor), The Salton Sea, Carnegie Institution of Washington Publication 193, 182 p.

Brown, J. S., 1920, The Salton Sea region, California: U. S. Geological Survey Water-Supply Paper 490-A, 86 p.

Brown, J. S., 1923, Routes to desert watering places in the Salton Sea region, California: U. S. Geological Survey Water-Supply Paper 497, 292 p.

Buwalda, J. P., and Stanton, W. L., 1930, Geological events in the history of the Indio Hills and Salton Basin, southern California: Science, vol. 71, p. 104-106.

California Energy Commission, 2000, Paleontological resources: in Regulations pertaining to the rules of practice and procedure & generating facility site certification, 3 p.

California State Historic Preservation Office, 1983, Summary of state/federal laws protecting cultural resources: California State Historic Preservation Office, Sacramento, California, 4 p.

Crowell, J. C., and Baca, B., 1979, Sedimentation history of the Salton Trough: p. 101-110 in Crowell, J. C., and Sylvester, A. G. (editors), Tectonics of the juncture between the San Andreas fault system and the Salton Trough, southeastern California -- a guidebook, University of California Santa Barbara, California, 89 p.

Dibblee, T. W., Jr., 1954, Geology of the Imperial Valley region, California: p. 21-28 in Jahns, R. H. (editor), 1954, Geology of Southern California: California Division of Mines Bulletin 170, 289 p.

Dibblee, T. W., Jr., 1984, Stratigraphy and tectonics of the San Felipe Hills, Borrego Badlands, Superstition Hills, and vicinity: p. 31-44 in Rigsby, C. A. (editor), The Imperial Basin – tectonics, sedimentation and thermal aspects, Pacific Section, Society of Economic Paleontologists and Mineralogists, Special Publication no. 40, 95 p.

Fenneman, N. M., 1931, Physiography of western United States: McGraw-Hill Book Company, New York, New York, 534 p.

Fisk, L. H., and Spencer, L. A., 1994, Highway construction projects have legal mandates requiring protection of paleontologic resources (fossils): p. 213-225, in: Scott F. Burns (editor), Proceedings of the 45th Highway Geology Symposium, Portland, Oregon, 258 p.

Fisk, L. H., Spencer, L. A., and Whistler, D. P., 1994, Paleontologic resource impact mitigation on the PGT-PG&E Pipeline Expansion Project, Volume II: PG&E Section, California: unpublished report prepared for the Federal Energy Regulatory Commission, California Public Utilities Commission, Pacific Gas and Electric Company, and Bechtel Corporation by Paleo Environmental Associates, Inc., Altadena, California, 123 p.

Free, E. D., 1914, Sketch of the geology and soils of the Cahuilla Basin: p. 21-33 in MacDougal, D. T. (editor), The Salton Sea, Carnegie Institution of Washington Publication 193, 182 p.

Gobalet, K. W., 1992, Colorado River fishes of Lake Cahuilla, Salton Basin, southern California -- a cautionary tale for zoo-archaeologists: Bulletin of the Southern California Academy of Sciences, vol. 91, no. 2, p. 70-83.

Gobalet, K. W., 1994, Additional archeological evidence for Colorado River fishes in the Salton Basin of southern California: Bulletin of the Southern California Academy of Sciences, vol. 93, no. 1, p. 38-41.

Hay, O. P., 1927, The Pleistocene of the western region of North America and its vertebrate animals: Carnegie Institute of Washington Publication 322(B), 346 p.

Herzig, C. T., and Mehegan, J. M., 1987, Quaternary depositional history of an active pull-apart basin, Salton Trough, California: Geological Society of America Abstracts with Programs, vol. 19, no. 7, p. 701.

Hubbs, C. L., and Miller, R. R., 1948, The Great Basin, part II, the zoological evidence: University of Utah Bulletin, vol. 38, no. 20, p. 103-113.

Hubbs, C. L., Bien, G. S., and Suess, H. E., 1963, Radiocarbon dates, La Jolla III: Radiocarbon, vol. 5, p. 254-272.

Jahns, R. H. (editor), 1954, Geology of Southern California: California Division of Mines Bulletin 170, 289 p.

Jefferson, G. T., 1991a, A catalogue of Late Quaternary vertebrates from California, part one, nonmarine lower vertebrate and avian taxa: Natural History Museum of Los Angeles County Technical Reports, no. 5, 60 p.

Jefferson, G. T., 1991b, A catalogue of Late Quaternary vertebrates from California, Part Two, mammals: Natural History Museum of Los Angeles County Technical Reports, Number 7, 129 p.

Jenkins, O. P., 1938, Geologic map of California: California Division of Mines and Geology, Sacramento, CA, (1:500,000 scale).

Jennings, C. W., 1967, Geologic map of California, Salton Sea Sheet: California Division of Mines and Geology, Sacramento, California (1:250,000 scale).

Jennings, C. W., 1977, Geologic map of California: California Division of Mines and Geology, Sacramento, California (1:750,000 scale).

Lander, E. B., 1989, Interim paleontological resource technical report, Eastside Reservoir Project Study--Phase 1, Riverside County, California: unpublished report prepared for Metropolitan Water District of Southern California by Paleo Environmental Associates, Inc., Altadena, California, 20 p.

Lander, E. B., 1993, Paleontologic/cultural resource impact mitigation program final report: unpublished report prepared for Midway Sunset Cogeneration Company, Mojave Natural Gas Pipeline, and Kern County, California by Paleo Environmental Associates, Inc., Altadena, California, 57 p.

Loeltz, O. J., Ireland, B., Robison, J. H., and Olmsted, F. H., 1975, Geohydrologic reconnaissance of the Imperial Valley, California: U. S. Geological Survey Professional Paper 486-K, 54 p.

Longwell, C. R., 1954, History of the lower Colorado River and Imperial Depression: p. 53-56 in Jahns, R. H. (editor), Geology of southern California: California Division of Mines Bulletin 170, 289 p.

Lundelius, E. L., Jr., Graham, R. W., Anderson, E., Guilday, J., Holman, J. A., Steadman, D. W., and Webb, S. D., 1983, Terrestrial vertebrate faunas: p. 311-353, in: Porter, S. C. (editor), Late Quaternary environments of the United States, volume 1, the Late Pleistocene, University of Minnesota Press, Minneapolis, Minnesota, 407 p.

Marshall, L. G., 1976, Paleontological salvage and federal legislation: Journal of Paleontology, vol. 50, p. 346-348.

McKibben, M. A., 1993, The Salton Trough rift: p. 76-80 in Reynolds, R. E., and Reynolds, J. (editors), Ashes, Faults and Basins, San Bernardino County Museum Association Special Publication 93, 107 p.

Mendenhall, W. C., 1909a, Some desert watering places in southeastern California and southwestern Nevada: U. S. Geological Survey Water-Supply Paper 224, 98 p.

Mendenhall, W. C., 1909b, Ground waters of the Indio region, California: U. S. Geological Survey Water-Supply Paper 225, 56 p.

Merriam, R., and Bandy, O. L., 1965, Source of upper Cenozoic sediment in the Colorado Delta region: Journal of Sedimentary Petrology, vol. 35, no. 4, p. 911-916.

Miller, L. H., and DeMay, L., 1953, The fossil birds of California – an avifauna and bibliography with annotations: University of California Publications in Zoology, vol. 47, p. 47-142.

Morton, P. K., 1977, Geology and mineral resources of Imperial County, California: California Division of Mines and Geology, County Report 7, 104 p.

Muffler, L. J. P., and Doe, B. R., 1968, Composition and mean age of detritus of the Colorado River Delta in the Salton Sea Trough, southeastern California: Journal of Sedimentary Petrology, vol. 38, p. 384-399.

Muffler, L. J. P., and White, D. E., 1969, Active metamorphism of upper Cenozoic sediments in the Salton Sea geothermal field and the Salton Trough, southeastern California: Geological Society of America Bulletin, vol. 80, no. 2, p. 157-182.

Preston, E. M., 1893, Salton Lake: California State Mining Bureau Report 11, p. 387-393.

Reynolds, R. E., 1987, Paleontologic resource assessment, Midway-Sunset Cogeneration Project, Kern County, California: unpublished report prepared for Southern California Edison Company by San Bernardino County Museum, San Bernardino, CA, 15 p.

Reynolds, R. E., 1990, Paleontological mitigation program, Midway-Sunset Cogeneration Project, Kern County, California: unpublished report prepared for Midway-Sunset Cogeneration Company, by San Bernardino County Museum, San Bernardino, California, 45 p.

Rigsby, C. A., 1984, The Imperial Basin -- tectonics, sedimentation, and thermal aspects: Pacific Section Society of Economic Paleontologists and Mineralogists, Special Publication no. 40, 95 p.

Schoenherr, A. A., 1993, Rise and fall of the desert pupfish, Cyprinodon macularius, at the Salton Sea: p. 67-68 in Reynolds, R. E., and Reynolds, J. (editors), Ashes, Faults and Basins, San Bernardino County Museum Association Special Publication 93, 107 p.

Shipman, P., 1977, Paleoecology, taphonomic history and population dynamics of the vertebrate assemblage from the middle Miocene of Fort Turnan, Kenya: unpublished Ph.D. Dissertation, New York University, New York, 193 p.

Shipman, P., 1981, Spatial distribution of fossils in sediments, p. 65-98, in P. Shipman, Life history of a fossil, an introduction to taphonomy and paleoecology: Harvard University Press, Cambridge, Massachusetts, 222 p.

Society of Vertebrate Paleontology, 1991, Standard measures for assessment and mitigation of adverse impacts to nonrenewable paleontological resources: Society of Vertebrate Paleontology News Bulletin, vol. 152, p. 2-5.

Society of Vertebrate Paleontology, 1995, Assessment and mitigation of adverse impacts to nonrenewable paleontologic resources – standard guidelines: Society of Vertebrate Paleontology News Bulletin, vol. 163, p. 22-27.

Society of Vertebrate Paleontology, 1996, Conditions of receivership for paleontologic salvage collections: Society of Vertebrate Paleontology News Bulletin, vol. 166, p. 31-32.

Spencer, L. A., 1990, Paleontological mitigation program, Midway-Sunset Cogeneration Project, Natural Gas Pipeline, Kern County, California: unpublished report prepared for Midway-Sunset Cogeneration Company by Paleo Environmental Associates, Inc., Altadena, California, 12 p.

Stanley, G. M., 1962, Prehistoric lakes in Salton Sea Basin: Geological Society of America Special Paper 73, p. 249-250.

Stearns, R. E. C., 1879, Remarks on fossil shells from the Colorado Desert: American Naturalist, vol. 13, no. 3, p. 141-154.

Thomas, R. G., 1963, The late Pleistocene 150-foot fresh water beachline of the Salton Sea: Bulletin of the Southern California Academy of Sciences, vol. 62, pt. 1, p. 9-18.

Threet, R. L., 1978, Eolian and lacustrine geomorphology of the western part of Salton Sink: National Association of Geology Teachers, Far Western Section, Field Guide for Two Trips in the Imperial Valley, California, p. 1-16.

Van de Kamp, P. C., 1973, Holocene continental sedimentation in the Salton Basin, California – a reconnaissance: Geological Society of America Bulletin, vol. 84, p. 827-848.

Waters, M. R., 1983, Late Holocene lacustrine chronology and archaeology of ancient Lake Cahuilla, California: Quaternary Research, vol. 19, p. 373-387.

Whistler, D. P., Lander, E. B., and Roeder, M. A., 1995, A diverse record of microfossils and fossil plants, invertebrates, and small vertebrates from the late Holocene Lake Cahuilla beds, Riverside County, California, p. 109-118 in Remeika, P., and Sturz, A. (editors), Paleontology and geology of the western Salton Trough detachment, Anza-Borrego Desert State Park, California, Field trip guidebook and volume for the 1995 San Diego Association of Geologist's field trip to Anza-Borrego Desert State Park, vol. 1, San Diego Association of Geologists, San Diego, California, 189 p.

Wilke, P. J., 1980, Prehistoric weir fishing on recessional shorelines of Lake Cahuilla, Salton Basin, southwestern, California: Proceedings of the Desert Fishes Council, vol. 11, p. 101-102.

Zimmerman, R. P., 1981, Soil survey of Imperial County, California, Imperial Valley area: U. S. Department of Agriculture, Soil Conservation Service, Washington, DC, 112 p.

Table 5.7-1
LAWS, ORDINANCES, REGULATIONS, AND STANDARDS APPLICABLE TO PALEONTOLOGICAL RESOURCES

Project LORS	Applicability	AFC Reference	Conformity
Antiquities Act of 1906	Protects paleontological resources on federal lands	Section 5.7.5.1	Yes
CEQA	Fossil remains may be encountered by earth-moving	Section 5.7.5.2	Yes
Public Resources Code Sections 5097.5/5097.9	Would apply only if project impacts occurred on lands either owned or managed by the State of California	Section 5.7.5.2	Yes

Table 5.7-2
AGENCY CONTACTS

Agency	Contact	Title	Phone Number and Address
Western Area Power Administration	George Perkins	Environmental Specialist Regional Coordinator	(303) 275-1713 P.O. Box 3402 1627 Cole Blvd., Bldg. 18 Golden, CO 80401-0098
Bureau of Land Management, California Desert Division	Tim Salt	District Manager	(909) 697-5206 5221 Box Springs Blvd. Riverside, CA 92507